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Analysis of the characteristics of lightning induced forest fires support fire hazard modelling in Austria

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Besides human caused fires, lightning is the major reason for forest fire ignition worldwide. However, information on fire events, lightning characteristics and impact points is often missing or controversial, due to the difficulty of lightning stroke localization and the relation to single forest fire events.

Austria as an Alpine country experiences a high number of thunderstorms and lightnings. With data from the Austrian Lightning Detection and Information System it was possible to link single lightnings and their characteristics to the location and attributes of individual forest fires. Additional data on the time of ignition, burned area, sea level, exposition and burned vegetation were investigated. A probability was estimated for each forest fire being caused by lightning, using a decision tree and decision matrices based on flash characteristics (e.g. amplitude, time, location). It could be shown that 15% of all recorded forest fires in Austria were lightning caused. Nearly all lightning caused fires were found during the summer months whereas almost 40% of all fires occurring from June to August were naturally caused. Most lightning caused fires took place in the south and east of Austria. They primarily occurred at higher altitudes with southerly or western exposition, mainly in stands of Norway spruce (Picea abies L.). Pine species were four times more often affected than the actual tree species distribution in Austria would assume. The median burned area was lower than for anthropogenic forest fires.

Three subsets with lightning data were compiled and analyzed regarding their strength (kiloampere), polarity (positive or negative) and multiplicity (number of re-strokes). Two fire weather sub-indices (FFMC – Fine Fuel Moisture Code and BUI – Build Up Index) of the Canadian Fire Weather Index were calculated for the location of the impact point of each lightning and over a period of twenty days, including the day of ignition. It was found that positive lightnings were relatively seen more likely to induce a fire. Both the FFMC and BUI showed a significant mean decrease after the day of ignition. Precipitation was significant lower at those impact points where forest fires were ignited. Burned area was larger when lightnings ignited during day hours and when BUI on ignition day was higher.

The study results contribute to the international discussion on the characteristics of lightning caused fires and provide input for predicting natural caused forest fires in an integrated fire danger model. Therefore we also demonstrate in this contribution, how the analysis of the empirical data can be used to design a conceptual model for forecasting the probability of lightning caused fires.